FA24 Telecom Systems Engineer Course

Practical Exercise 2: CSU/DSU

OBJECTIVES

The objective of this lab is to gain an understanding of the functionality of a CSU/DSU system employed within an Internet Protocol (IP) communications network. Students will also gain experience with the TTC Fireberd 6000 Communications Analyzer to assess the information throughput over the installed WAN link between the two CSU/DSU systems.

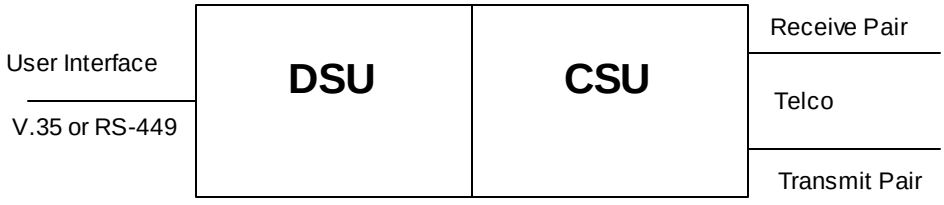
INTRODUCTION

CSU/DSU: Short for ***C****hannel* ***S****ervice* ***U****nit* ***/ D****ata* ***S****ervice* ***U****nit.* The DSU is a device that connects a terminal to a digital line. The CSU is a device that performs protective and diagnostic functions for a telecommunications line. Typically, the two devices are packaged as a single unit. You can think of it as a very high-powered and expensive modem. Such a device is required for both ends of a DS-1 or DS-3 connection.

The Department of Defense uses thousands of CSU/DSUs in sustaining base, long-haul and occasionally tactical communication circuits. For instance, most of the Global Command and Control System (GCCS), SIPRNET, and Joint Worldwide Intelligence Communications System (JWICS) networks are interconnected using CSU/DSUs. The most popular serial connections are DS1, 64 kbps and 56 kbps lines. To establish this service, a Request For Service (RFS) is submitted through appropriate channels. If approved, the circuit is provisioned through the Defense Information Systems Agency (DISA). This line terminates into a CSU that is located on the customers' premise. A DSU is used to terminate the slower 56/64 kbps DDS line. (For historical reasons T1/E1 devices are usually referred to as CSUs and sub-rate devices are referred to as DSUs). In most cases, the T1 line will terminate into a single device that has both DSU and CSU functionality. However, DSUs and CSUs can be sold separately.

The primary function of the DSU is to convert the user generated signals such as RS-232 or V.35 into the form needed for transmission over the line provided by the local carrier. This conversion manipulates (conditions) the user-input signal into the specified line code and framing format. The DSU is used to interconnect Data Terminal Equipment (DTE) for the public telephone network. It is a type of short-haul, synchronous-data line driver. It is normally installed at a user location that connects a user's synchronous equipment over a 4-wire circuit, at a present transmission rate, to a servicing Dial Central Office (DCO). This service can be for a point-to-point or multi-point operation in a Digital Data Network (DDN).

The primary function of the CSU is to protect the local carriers network from the users' network, track statistics, and provide loop-back testing for the local carrier (Figure 2-6 / Access-T Loopback Paths). The CSU provides signal conversion and maintains the local loop's electrical characteristics. It is a line bridging device that is the last signal regeneration point before a multiplexer or the DTE. The CSU also may perform bit stuffing; provides a framing and formatting pattern compatible with the network. Figure 1 shows the basic CSU/DSU diagram.



TTC Fireberd 6000 Communications Analyzer: The Fireberd 6000 is a common piece of diagnostic equipment that is found in almost every fixed site Dial Central Office or Technical Control Facility located in the Department of Defense. It is normally used as a simple Bit Error Rate (BER) tester to isolate communication circuit problems or to verify proper circuit operation; however, it can do more sophisticated diagnostics based on the interface card and software version. This lab will give a short introduction to the Fireberd 6000 – both into the functionality and common usage of the Fireberd 6000.

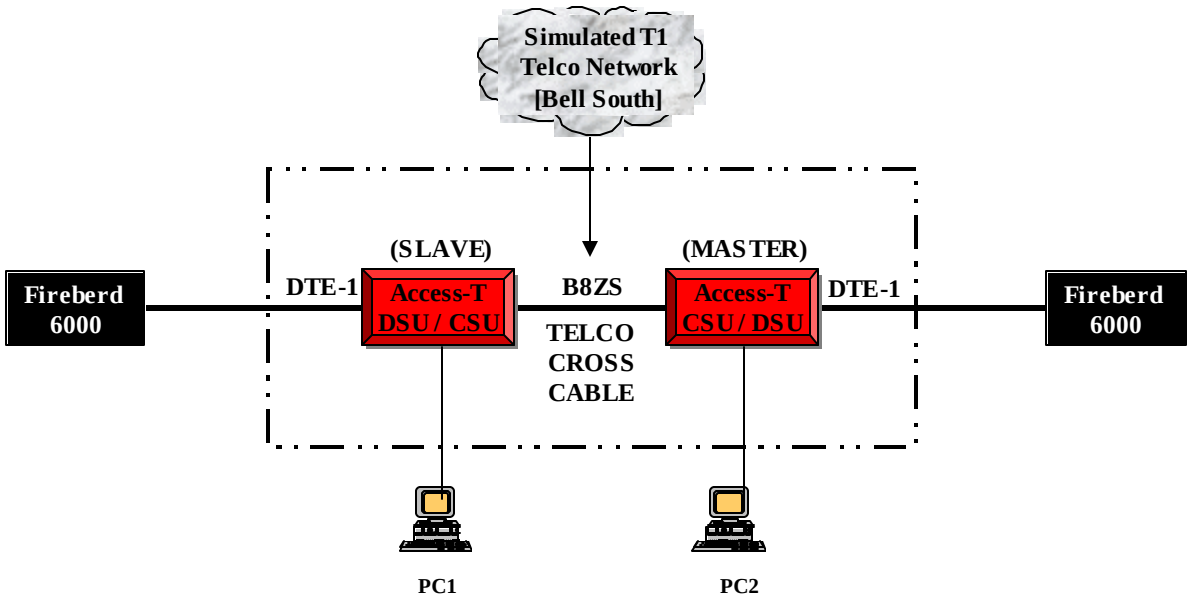
APPARATUS

REQUIRED EQUIPMENT	QTY
Larscom Access-T 200 CSU/DSU and Installation and Operation Manual	**2**
TTC Fireberd 6000 Communications Analyzer and User' s Guide.	**2**
Laptop with Hyper-terminal application	**2**
LARSCOM Telco Cross Cable	**1**
Networking cable: EIA-530 ✍ EIA-449 / MIL-STD-188-114 Balanced DCE Interface cable	**2**
LARSCOM Config. Cable	**2**
Lab Network Diagram	**1**

PROCEDURES

Students will configure the LARSCOM Access-T 200 Multi-port CSU/DSU System to connect two geographically distant customer sites via a 1536 kbps WAN / serial link. The WAN link between two CSU/DSU Systems will replicate a commercial carrier WAN link.

CSU/DSU Network Connectivity



Physical Connectivity

The first thing you must do is to physically connect the network IAW the diagram above.

Step 1. Connect the two LARSCOM Access-T 200 Multi-port CSU/DSU Systems together. The two units will be connected using a special TELCO cross cable that is provided to support the T1 serial connection between the two units. Make sure that the cable is connected to the J8 LINE port on the back of each CSU/DSU system.

Step 2. Connect the LARSCOM Access-T 200 Multi-port CSU/DSU Systems to the TTC Fireberd 6000 Communication Analyzers. Get a TTC Fireberd 6000 Communication Analyzer and place it on the left / right side of the table. Get an EIA-530 DTE serial cable and connect the correct end to the J1 DTE port or the J2 DTE port on the back of each CSU/DSU system. Connect the opposite end to the MIL-STD-188-114 BALANCED DCE INTERFACE of the TTC Fireberd 6000 Communication Analyzers.

Configure the LARSCOM Access-T 200 Multi-port CSU/DSU

There are seven (7) different screens that can be configured to enable the two CSU/DSU systems to communicate via a serial link. Each screen has several options that can be selected for different applications. You will configure the CSU/DSU systems to use the settings that are listed in the steps below. Once you have completed the configuration you will use the TTC Fireberd 6000 Communications Analyzers to view statistical data from the network.

Step 1. Turn on your CSU/DSU, go to the LINE SCREEN on the CSU/DSU and configure the system to support the following settings: Framing=D4 / Line Coding=AMI. Go to the DTE SCREEN on the CSU/DSU and configure the system to support the following settings: Port 1 + Rate=Nx56.

Step 2. Turn on your Fireberd 6000 systems. Verify the pre-sets on the Fireberd 6000 Communications Analyzer. The following settings should be selected prior to starting the lab. Data=QRSS / GEN CLK=INTF / Timing Mode=SYNC / Interface=MILBAL / Analyze Results Category [Right Side] =SIGNAL + RCV FREQ / Analyze Results Category [Left Side]=ERROR + BIT ERRS. The CSU/DSU systems are setup for AMI encoding and D4 framing.

[Q1. 1 Point] What is the current receive-frequency for the Fireberd 6000?

Step 3. Look at the NETWORK *"LINE"* indicator light on the front of the CSU/DSU system and record the color. _____ Go to the LINE SCREEN and the DTE SCREEN on the CSU/DSU and configure ONE CSU/DSU system to support the following settings: Framing=ESF / Line Coding=B8ZS / Port 1 + Rate=Nx64. Look at the NETWORK *"LINE"* indicator lights on the front of both CSU/DSU systems and record the color.

[Q2. 1 Point] What happened?

Now configure both CSU/DSU systems to support the following settings: Framing=ESF / Line Coding=B8ZS / Port 1 + Rate=Nx64.

[Q3. 1 Point] What happened when you changed the settings?

Step 4. Look at your Fireberd 6000 systems.

[Q4. 1 Point] View the RCV FREQ output and write down the current receive-frequency for the Fireberd 6000.

Step 5. Go to the REPORTS SCREEN and view the current LOCAL Configuration and answer the following questions:

[Q5. 9 Points] What is the NAME of the CSU/DSU system?
What information do you get from the MAP setting?
What is the FREQUENCY?
What is the MASTER CLOCK source?
What is the FRAMING?
What is the CODING?
What is the RATE for PORT 1?
What is the RATE for PORT 2?
What type of INTERFACE is being used?

Perform Network Analysis

Step 6. Set up a test loop to support this portion of the lab. Go to the TEST SCREEN and select the following options: *Line Loop + Remote-up + Line. [You should see a statement on your screen that says, "Far loop sent" and then the "Loop" indicator light will appear on the remote CSU/DSU system.]* Hit the escape key twice to return to the main menu screen. You are now ready to start your network analysis. Execute a Quasi-Random Signal Source (QRSS) test pattern and Bit Error Test on the Larscom Access-T 200 CSU/DSU System. *[Follow the instructions that are provided on pages 7-33 and 7-34 of the Larscom Access-T 200 CSU/DSU System Installation and Operation manual.]* Observe the results. *[Note: On step 3 of the QRSS test you will select the PORT 1 / 2 portion of the T1 bandwidth to transmit the QRSS signal. Your port selection will depend on the actual port that is being used on your particular*

CSU/DSU system.] Go to TEST SCREEN and execute the tests IAW the steps in the book. *[After you have completed the steps on page 7-33, the local CSU/DSU system's "TEST" indicator light illuminates to verify that you are sending a QRSS test pattern over the T1 line.]* Hit the *space bar* a few times and observe the BIT ERROR counter.

[Q6. 1 Point] What happens? Record the results.

Step 7. Perform specified *DTE Channel Loopbacks, Line Loopbacks* and *Remote Loopbacks* on the Larscom Access-T 200 CSU/DSU System. You will actually perform a *CS DTE loop, DS DTE loop, LS DTE loop, Remote LS Line loop and a Remote CS Line loop* to accomplish this task. *[Go to the Activating Loopbacks section on page 7-29 in the Larscom Access-T 200 CSU/DSU System Installation and Operation Manual to view the steps for establishing the different loopbacks. Follow the instructions and perform the loopbacks that are listed above.]* Record the results and get the lab instructor or TA to verify the results. You will employ the Fireberd 6000 Communications Analyzer to view the results and verify that the systems are working from end to end. *[The "SYNC LOST" section on the Fireberd 6000 will be used to support this portion of the experiment. The "RECEIVER" sub-categories of "MK", "SP" and "SYNC" lights should illuminate when the loopback test is successful.]*

[Q7. 1 Point] Record you results/observations.

Drop all of your loops and place the CSU/DSU systems back in their normal operating mode.

Note: There are a few things you should know about setting up the Fireberd 6000 Communications Analyzer before you perform Step 8. Paragraphs 2.1 and 2.2 on pages 2-1 through 2-13 in the Fireberd 6000 User's Guide discuss the SECTION SUMMARY (Para 2.1) and the KEY ELEMENTS OF FIREBERD 6000 TESTING (Para 2.2). There are six (6) key elements that are listed in paragraph 2.2 that are used in various capacities to set up or execute a Fireberd 6000 test. Figure 2-1 on page 2-2 shows the front panel of the Fireberd 6000. Please use the book to gain additional information on the different categories of data / test results that can be observed by employing the Fireberd 6000 Communications Analyzer. The QRSS data pattern is the standard data pattern for T1 testing. We will set the Fireberd 6000 Communications Analyzer to this mode to perform all of our tests. The other settings will be addressed in the step.

Step 8. Use the Fireberd 6000 Communications Analyzer to analyze the communication circuit for desired results. Go to the Fireberd 6000 and set the ANALYSIS RESULTS "*CATEGORY*" to "*ERROR*" on both Fireberd 6000 systems. Press the ERROR INSERT button on the lower left side of the *(local)* Fireberd 6000 system.

[Q8. 1 Point] What happens to the "BER" counter?

Push the left *RESULT* button until the "BLOCKS" results are displayed on the screen to see the results.

[Q9. 1 Point] What happens and what does the "BLOCKS" data information tell you?

Step 9. Set one Fireberd 6000 system to display "AVG BER" results. Use your left ANALYSIS RESULTS *CATEGORY* button and the left *RESULTS* button to select the "AVG BER" option and display the results. Hit the RESTART button and allow the "ELAP TIM" to reach five (5) minutes. *[This is the elapse time recorder.]* Go to the remote Fireberd 6000 system and insert errors until the "AVG BER" on the local

Fireberd 6000 system reaches approximately $1x10^{-6}$ " AVG BER" reading. When that occurs, go to the " BIT ERRS" results counter and record the number of bit errors that are displayed. *[Normally the commercial standard for a DS1 rate is $1x10^{-6}$ quality.]*

NOTE: Include all procedure questions in your group report. Include the Discussion Questions (below) in your individual report.

DISCUSSION

[Q10, 5 points] Describe the functions a CSU performs in your own words.

[Q11, 5 points] Describe the functions a DSU performs in your own words.

[Q12, 5 points] Describe the difference(s) between a CSU and a DSU?

[Q13, 2 points] What LINE CODING and FRAMING can be implemented between the two CSU/DSUs for you to communicate across the network?

[Q14, 10 points] In step 2, the observed frequency was 1344 kHz. Based on the frame type and signal encoding, explain in detail why the frequency was less than the 1544 kHz which is the total bandwidth for a DS1.

[Q15, 5 points] In step 3, explain why the network light turned red when you changed one CSU/DSU to ESF, B8ZS and Nx64.

[Q16, 10 points] In step 4, the new observed frequency was 1536 kHz. Based on the frame type and signal encoding, explain in detail why the frequency was less than the 1544 kHz which is the total bandwidth for DS1.

[Q17, 5 points] What is QRSS? Where is it used? What bit pattern does the QRSS data use?

[Q18, 5 points] In step 6 and 8, why would you purposely want to insert bit errors into your system?

[Q19, 5 points] In step 9, based on the number of bit errors required before a circuit failed the DS1 standard, would you want a marginal DS1 data circuit? Why not? In what applications may a marginal DS1 circuit be adequate?

REFERENCES

Books

Comsphere 3500 Series Data Service Units, User's Guide

Comer, Douglas E. *Internetworking With TCP/IP Volume One*

Huitema, Christian, *Routing in the Internet*

Kessler, Andrew. *Integrated Systems Testing for Network*, Student Seminar Presentation, spring 1996

Newton, Harry. *Newton's Telecom Dictionary*

Steinke, Steve. "Getting Data Over the Telephone Line, Lesson 92: CSUs and DSUs." *LAN*, Apr 96.

Cisco Systems, Inc. *Cisco Systems Configuration Guide for Cisco 3600 Series and Cisco 2600 Series Routers.*

LARSCOM, Inc. *Access-T 100,200,300,400, & 1500 Multi-port CSU/DSU System Installation and Operation Manual,* June 1996.

Telecommunications Techniques Corporation (TTC) *FIREBERD 6000 Communications Analyzer User's Guide,* November 1989.

Useful Web Sites for Computer / Networking related information:

LARSCOM Access-T web site – www.larscom.com

Cisco Systems, Inc. - http://www.cisco.com

Astrocom - http://www.astrocorp.com/univers/introdsu.shtml

AOL technical site - http://www.aol.pcwebopedia.com